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INK JET PRINT HEAD
[TINTENSTRAHL-SCHREIBKOPF]

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FOREIGN TITLE [54A]: TINTENSTRAHL-SCHREIBKOPF

Patent Claims /1*

1. An ink jet print head, characterized by a cover plate (2) with a first surface, a second surface, and an ink feed groove (6), by a first piezoelectric plate (1) with a first surface, a second surface, and an edge, the second surface of the first piezoelectric plate (1) being attached to the first surface of the cover plate (2) and having a plurality of first ink reservoirs (3) made therein, and each of the first ink reservoirs (3) being in fluid connection with

1. an associated first ink passage (4) connecting the ink feed groove (6) and the first ink reservoir (3) and with

2. an associated first ink jet nozzle (5) for ejecting ink out of the first ink reservoir (3) on the edge of the first piezoelectric plate (1), and

by a second piezoelectric plate (1) with a first surface, a second surface, and an edge covered with the edge of the first piezoelectric plate (1), the second surface of the second piezoelectric (1) being attached to the second surface of the cover plate (2) and having a plurality of second ink reservoirs (3) made therein, and each of the second ink reservoirs (3) being in fluid connection with

1. an associated second ink passage (4) connecting the ink feed groove (6) and the second ink reservoir (3) and with

2. an associated second ink jet nozzle (5) for ejecting ink out of the second ink jet reservoir (3) on the edge of the second

*Numbers in the margin indicate pagination in the foreign text.

piezoelectric plate (1), the first and the second ink jet nozzles (5) being provided alternating on the first and the second surface of the cover plate (2).

2. The ink jet print head according to Claim 1, wherein the first piezoelectric plate (1) includes a first guide on its first surface and a second guide on its second surface.

3. The ink jet print head according to Claim 1 or 2, wherein the second piezoelectric plate (1) includes a third guide on its first surface and a fourth guide on its second surface.

4. The ink jet print head according to at least one of the preceding Claims, wherein the majority of the first ink reservoirs (3) include a plurality of first sections (3a), that are made in the second surface of the first piezoelectric plate (1), and that the plurality of the second ink reservoirs (3) include a plurality of second sections (3a) that are made in the second surface of the piezoelectric plate (1).

5. The ink jet print head according to at least one of the preceding Claims, wherein adjacent first ink reservoirs (3) are separated from one another by a groove (9), that passes from the first surface of the first piezoelectric plate (1) to the second surface thereof and from the edge of the first piezoelectric plate (1) to a place between the adjacent first ink reservoirs (3).

6. The ink jet writing head according to at least one of the preceding Claims, wherein adjacent second ink reservoirs (3) are separated by a groove (9), that passes from the first surface of the

second piezoelectric plate (1) to the second surface thereof and from the edge of the second piezoelectric plate (1) to a second place between the adjacent second ink reservoirs (3).

7. The ink jet print head according to at least one of the preceding Claims, wherein adjacent first ink jet nozzles (5) are separated by a line in the range of 0.25 mm to 0.5 mm.

8. The ink jet print head according to at least one of the preceding Claims, wherein adjacent second ink jet nozzles (5) are separated by a line in the range of 0.25 mm to 0.5 mm.

9. The ink jet print head according to at least one of the preceding Claims, wherein the cover plate (2), the first piezoelectric plate (1), and the second piezoelectric plate (1) have thickness measurements of in each case approximately 0.5 mm.

10. The ink jet print head characterized by a cover plate with a first surface, a second surface, and an ink feed groove, by several first ink jet devices, that are formed on the first surface of the cover plate for selective ejection of ink from the ink feed groove, and by several second ink jet devices, that are formed on the second surface of the cover plate for the selective ejection of ink from ink feed groove, the first ink jet devices and the second ink jet devices being provided alternating along an edge of the cover plate.

11. The ink jet print head in accordance with Claim 10, wherein each of the first ink jet devices includes a first ink reservoir, a first ink passage groove connecting the first ink reservoir with the ink feed groove, and a first ink jet nozzle connecting with the first

ink reservoir.

12. The ink jet print head according to Claim 10 or 11, wherein each of the second ink jet devices includes a second ink reservoir, a second ink passage connecting the second ink reservoir with the ink feed groove, and an ink jet nozzle connecting the second ink reservoir.

Description

The invention concerns an ink jet print head, that forces ink drops out of nozzles by means of piezoelectric effect. In /2 particular the invention concerns an ink jet print head of the multiple nozzle design with a large number of ink nozzles that are arranged in a horizontal row.

In order to improve the resolution of a piezoelectric ink jet print head it is necessary to arrange a large number of ink nozzles precisely separated by very short distances. Japanese patent application (OPI) No. 56 150/87 (the term "OPI" here means an "unexamined published application" disclosed an ink jet print head with a plurality of ink reservoir grooves, that are provided in a flat plate made out of a piezoelectric material and connected with a cover plate.

The ink jet print head disclosed in this application includes piezoelectric elements, that have ink reservoirs. The number of piezoelectric elements is equal to the number of ink nozzles. Although the ink jet print head is made compact and is relatively simple to produce, it does not achieve a maximum density of ink drops

and may be further reduced in accordance with the invention.

One goal of the invention is an ink jet print head, in which the separations or distances between adjacent ink nozzles are reduced for improving the resolution of the ink jet print head.

Another goal of the invention is an ink jet print head with an enlarged dot density.

These and other goals are achieved by means of an ink jet print head with a cover plate, that has a first surface, a second surface, and an ink feed groove, with a first piezoelectric plate that has a first surface, a second surface, and an edge, the second surface of the first piezoelectric plate being attached to the first surface of the cover plate and having a plurality of first ink reservoirs made therein, and each of the first ink reservoirs being in fluid connection with

1. an associated first ink passage connecting the ink feed groove and the first ink reservoir and with

2. an associated first ink jet nozzle for ejecting ink out of the first ink reservoir on the edge of the first piezoelectric plate, and with a second piezoelectric plate having a first surface, a second surface, and an edge covered with the edge of the first piezoelectric plate,

the second surface of the second piezoelectric being attached to the second surface of the cover plate and having a plurality of second ink reservoirs made therein, and each of the second ink reservoirs being in fluid connection with

1. an associated second ink passage connecting the ink feed groove and the second ink reservoir and with

2. an associated second ink jet nozzle for ejecting ink out of the second ink jet reservoir on the edge of the second piezoelectric plate,

the first and the second ink jet nozzles being provided alternating on the first and the second surface of the cover plate.

Next the invention is described in greater detail by means of a specific embodiment with reference to the drawing. Here:

Fig. 1 shows a partially cut perspective representation of a main part of a specific embodiment of the ink jet print head according to the invention,

Fig. 2 shows a section along line II-II in Fig. 1,

Fig. 3(A) shows a top view of the piezoelectric plate of the ink jet print head according to the invention,

Fig. 3(B) shows a section along the line B-B in Fig. 3(A),,

Fig. 3(C) shows a section along line C-C in Fig. 3(a),

Fig. 4(A) shows a top view of the cover plate of the ink jet print head according to Fig. 1, and

Fig. 4(B) shows a section along line B-B in Fig. 4(a).

Two piezoelectric plates are provided from the ink jet print head according to the invention. The plates are connected with the two sides of a cover plate so that a plurality of ink reservoirs is formed by the ink jet reservoir grooves and the cover plate. Ink nozzles are made, that are connected with the ink reservoirs on both sides of the

cover plate and are arranged in an interwoven (zigzag) pattern transversely over the cover plate.

Since the ink nozzles are arranged in a zigzag pattern transversely over the cover plate, the distance between two adjacent ink nozzles transversely over the cover plate is equal to half the distance between adjacent ink nozzles on each side of the cover plate.

According to Fig. 1 a pair of flat plates **1** produced out of piezoelectric material is mounted on corresponding surfaces of a cover plate **2** made of glass. As shown in Figs. 3(A) - (C), a plurality of ink reservoir grooves **3a**, a plurality of ink passage grooves **4a**, that are connected with the ink reservoir groves **3a**, and a plurality of ink nozzle grooves **5a**, that are connected with the ink reservoir grooves **3a**, are provided at intervals on one side of each piezoelectric plate **1**. The ends of the ink nozzle grooves **5a** are open (run to an edge) arranged opposite the ink reservoir grooves **4a** on the front side of the piezoelectric plate **1**, while the ends of the ink passage grooves **4a** arranged opposite the ink reservoir grooves in the piezoelectric plate are closed. Electrodes **8** are provided on both sides of each piezoelectric plate **1**.

As shown in Figs. 1 and 4(A), a slit **6** in the cover plate **2** is provided in such a way that it passes transverse to the ink passage grooves **4a** in the piezoelectric plates **1**, when the latter, as is described below, are connected with the cover plate **2**.

The piezoelectric plates are connected by means of adhesives, welding, or other means with the respective sides of the cover plate **2**. The ink jet nozzle grooves **5a** in the piezoelectric plates **1** are offset with respect to one another by a distance (to the right or to the left with reference to Figs. 1 and 2) that is equal to half the distance between adjacent ink nozzle grooves **5a** in each piezoelectric plate 1. Since the piezoelectric plates 1 are connected with the cover plate **2**, ink reservoirs **3**, ink passages **4**, and ink nozzles **5** are /3 formed on both sides of the cover plate **2** by the ink reservoir grooves **3a**, the ink passage grooves **4a**, and the ink reservoir grooves **5a** (ink nozzle grooves **5a**). The slit supplies al ink passages **4**.

Slits **9** are provided in the piezoelectric plates **1**, in order to divide the latter into mutually independent sections with separate ink reservoirs **3**. The electric plates **1** pass from the front sides of the piezoelectric plates **1** to the vicinity of the ink channel **6**. Since the ink nozzle grooves **5a** of the plates **1** connected with the sides of the cover plate **2** are offset with respect to one another, as already mentioned, the ink nozzles **5** are arranged in a zigzag or interwoven pattern transversely over the cover plate, as shown in Figs. 1 and 2, so that the distance between the adjacent ink nozzles transversely over the cover plate in equal to half the distance between adjacent ink nozzles in the same cover plate (piezoelectric plate).

A driver pulse voltage is applied between the electrodes **88**, after the ink reservoirs **3** of the ink jet print head have been filled

with ink. The capacitance of each ink reservoir is changed so that ink in the form of drops is ejected onto a recording medium not shown.

Examples of some dimensions of the ink jet print head now are given with reference to Fig. 2. The cross-section of each ink nozzle **5** amounts to 40 microns x 40 microns. The distance **A** between adjacent ink nozzles **5** in the same piezoelectric plate amounts to 0.5 mm. The thickness $\mathbf{L_1}$ of each piezoelectric plate **1** and the thickness $\mathbf{L_2}$ of the cover plate **2** are approximately 0.5 mm. The width **B** of each slit **9** amounts to approximately 50 microns. The width $\mathbf{C_1}$ of the section of the piezoelectric plate between the slits **9** amounts to 0.4 mm. The width $\mathbf{C_2}$ of each ink reservoir **3** amounts to 0.2 mm. Consequently, the distance **D** between the ink nozzles **5** adjacent to one another transversely over the cover plate **2** amounts to 0.25 mm. In other words, there are four ink nozzles **5** per mm. Thus the resolution of the ink jet print head is four dots per mm.

A plate-cutting saw for cutting semi-conductor disks may be used, for example, in order to make the ink jet print head. Sine a cutting blade with a thickness of 15 µm already has been developed for such a plate-cutting saw, the ink reservoir grooves, the ink nozzle grooves, the ink passage grooves, etc. may be cut by means of such a plate-cutting saw.

Although the distance **A** between adjacent ink nozzles on a piezoelectric plate amounts to 0.5 mm in the above-mentioned example, the distance may be changed to 0.25 mm, if a plate-cutting saw with a

very thin cutting blade is used. In this case there may be 8 ink nozzles per mm.

In accordance with the invention an ink jet print head consists of a cover plate and two piezoelectric plates, that have a plurality of ink reservoir grooves and are connected with corresponding sides of the cover plate, so that a plurality of ink reservoirs is formed by the ink reservoir grooves and the cover plate. Ink nozzles are connected with the ink reservoirs on both sides of the cover plate and are arranged in a zigzag pattern transversely over the cover plate. For this reason the distance between adjacent nozzles transversely over the cover plate may be adjusted to half the distance between adjacent ink nozzles on each piezoelectric plate, in order to improve the resolution of the ink jet print head and to make the head more compact.

FIG. 4(A)

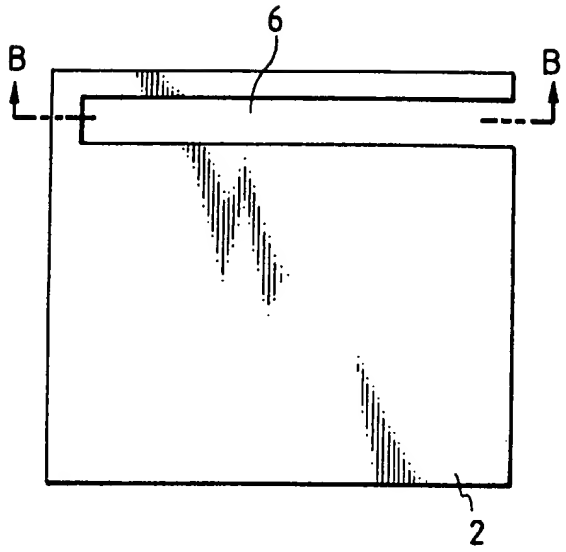

FIG. 4(B)

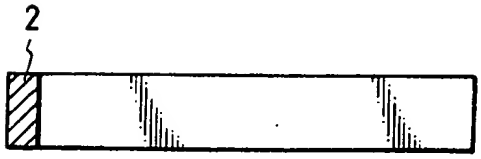

Fig. : 1/2 : 1/1 P 21 744

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FIG. 1

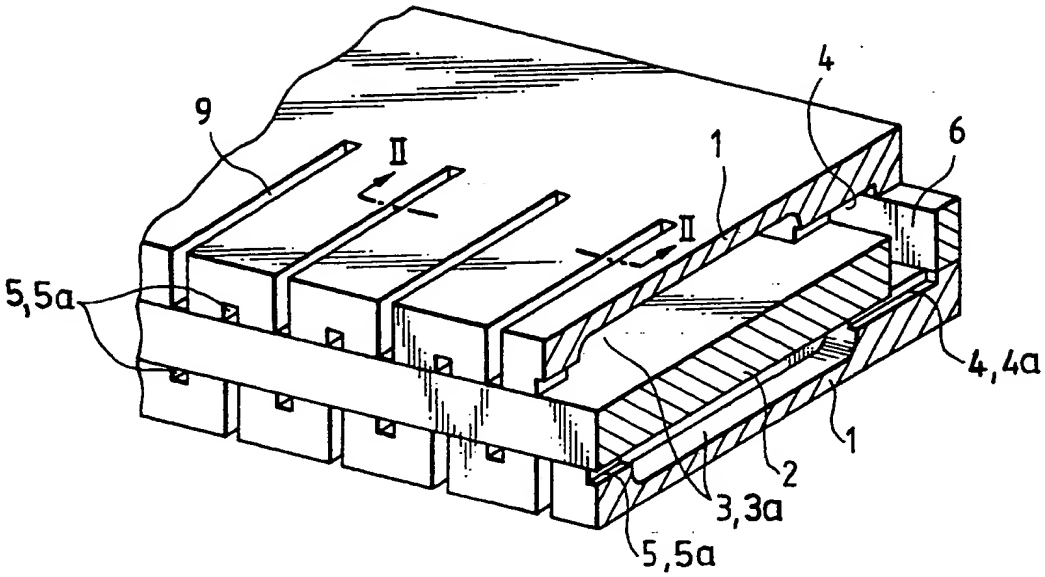

FIG. 2

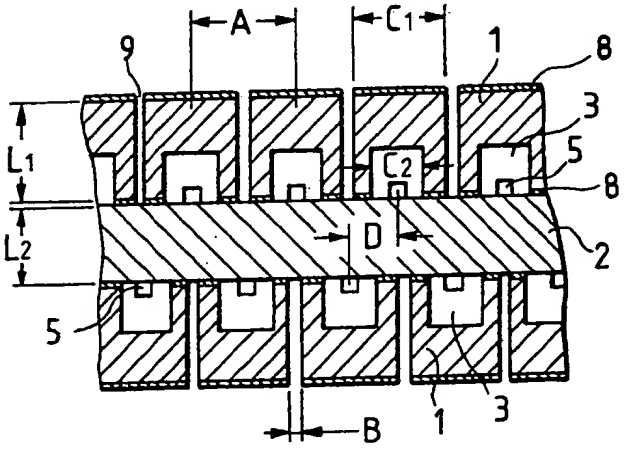

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FIG. 3(A)

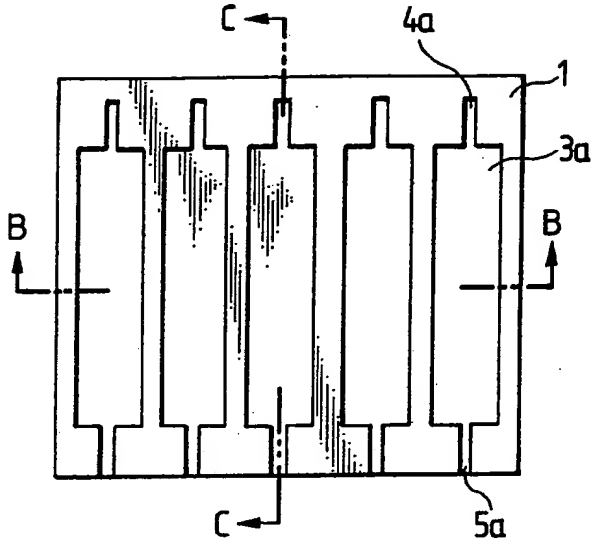

FIG. 3(B)

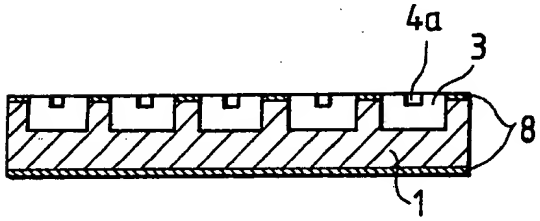

FIG. 3(C)